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ABSTRACT

This paper describes the Scientific Tools and Techniques course for ninth grade students in the Dekalb County, Georgia, public high schools. The course is offered at the Fernbank Science Center, a magnet school owned by the Dekalb County Schools and Fernbank Incorporated and operated by the school system. Investigations are described in the following areas of physics: (1) electricity; (2) falling objects; (3) momentum; (4) radiation; (5) optics; and (6) sound. In each session, students learn concepts, use equipment, collect data, do computations, draw conclusions, and write laboratory reports. There are few lectures, no textbooks, no tests, and no problem sets. (JM)

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A Very Brief Laboratory Course in Physics for Ninth Grade Students

by
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paper presented at the
1986 Joint Winter Meeting of the
American Association of Physics Teachers and the
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Abstract: The Fernbank Science Center runs a magnet program (Scientific Tools and Techniques) emphasizing real laboratory and field experience. The physics segment meets only six times, for about four hours each session, with ten students. The challenge for the instructor is to accurately represent the entire discipline within this framework. Five original labs were developed in motion, optics, electronics, radiation, and sound, using college level apparatus. In each session, students collect data, do computations and graphing, discuss results, and then write up a lab report (a micro learning-cycle approach). Tours of university facilities are also part of the course. The philosophy, teaching methods, lab manual and software developed for this program will be discussed.

Fernbank Science Center The Fernbank Science Center is an educational facility with a museum, observatory, planetarium, experimental gardens, forest, and resource laboratories in several areas of science. It is owned by DeKalb County Schools and a private organization, Fernbank Incorporated, but is operated by the school system.

The STT Program The Fernbank Science Center runs the *Scientific Tools and Techniques* course for ninth grade students in the DeKalb County School system's 21 high schools. During each 12-week academic quarter, 60 students are selected to participate. Students are picked up at their home schools,

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and are bused to the Center. During the mornings (9:00 - 12:45) they have science classes, following a complicated rotating schedule. After lunch, they have a mathematics class (1:15 - 2:15) and are then returned to their high schools in time to participate in extracurricular activities. As a "magnet" program, the STT student body is unusually diverse: all racial and ethnic groups are represented, and there is an approximately equal number of males and females.

Philosphy It is well known that in order to learn about science, students must actually *do* science. In most school situations, talking, reading and writing necessarily predominate. But in a Science Center, with its specialized laboratories and experienced personnel, it is possible to give students a much more realistic and intensive experience. They find out what science is, what scientists actually do, and they can then make career choices based on accurate information. The program is geared to the second year in high school so that students will not have to interrupt important full-year course sequences (which often begin in tenth grade) and so that after completion of the program students will still have three more pre-college years in which to take mathematics and science courses. Preliminary follow-up studies show that STT graduates actually do go on to take more technical course work.

The Science Curriculum In each of a dozen areas of science, instructors constructed a set of experiences for the students

which reflected methods and equipment appropriate to the discipline. In some mini-courses, a strong emphasis on descriptive content and cognitive methods emerged. In others, courses in instrumental methods were developed. Such diversity, coupled with natural differences in the instructors interests and temperament, it was felt, only enriched the students experiences.

The Physics Curriculum Students often walk into the laboratory on the first day of the course, and ask "Oh, this must be physics. What is physics, anyway?" The entire experience has been developed to answer this question. The problem is, how to accurately reflect the entire discipline in six four-hour sessions. As it has developed, each session is a separate investigation of a different area of physics. In each session, students learn concepts, learn to use equipment, take data, do computations (using original software), draw conclusions, and write up a formal lab report. There are few lectures, no textbooks (but many original handouts and articles), no tests or recitations, and no problem sets. The guiding principle is to make their few hours as authentic as possible a simulation of what a physicist would do in an actual work situation.

Two Weeks in the Lives of STT Physics Students (this section of the paper is informal narration accompanying 35-mm slides which show an STT group of 10 students as they go through the physics cycle).

1. Whenever possible, the first lab is on electricity, using a variable power supply and a variable resistor. When graphing potential vs. current, students find a family of straight lines through the origin. This leads to the technique of finding a slope from data, and the idea that slopes of lines have meanings in physics. This is short, it never fails, and it gets them off to a good start.

2. The second lab is on motion of a falling object. Students drop a golf ball, illuminated by a variable stroboscope. A time-exposure polaroid photograph is measured to find the positions, which are entered into the computer. Each student gets a table of positions, speeds and accelerations. They graph the speeds and find that the slope is also the acceleration.

3. Because of a quirk in the schedule, this group got an extra day, so they investigated conservation of energy and momentum in an air-track collision. Again, they measured positions, and all of the rest of the calculations were done by the computer.

4. Some of our radiation equipment is shown, including an x-ray diffraction machine, and a Cs-137 gamma irradiator. The students use Thornton-module geiger counters to measure the decay of Ba-137m, do a semi-logarithmic graph and find the half-life.

5. Optics is next. Students use a small NeNe laser to find

the index of refraction of plexiglas, learning some trigonometry. They also got to make a transmission hologram using the optics table.

6. If the purpose of the STT Physics Course is to learn what physics is, then it is important for them to see some real researchers with state of the art equipment. Through a special arrangement with the School of Physics at Georgia Tech, each STT group gets to visit two different research labs. Shown here are Prof. Peter Schulz, demonstrating his big Nd/YAG laser, and Paul R., a graduate student in Prof. Ray Young's labs, showing X-ray diffraction equipment. From Physics, we went to nuclear engineering, where Dr. R.A. Karam, the director, showed students the hot cell and the reactor. We finished off the morning with a visit to the computer center, where students got to look inside the mainframe.

7. The last lab is on sound. Students rotate through three short experiments. One is on audible sound, particularly pitch and sound. Students are shown using the laser scanner as an oscilloscope. Another lab convinces them that ultrasound exists, and they also get to scream into a sound level meter.